

LEVEL II BRIDGE SCOUR ANALYSIS REPORT  
OF  
STRUCTURE NO. 18-2-0017-0-75-00  
US 17A OVER  
ASHLEY RIVER  
IN  
DORCHESTER COUNTY, SOUTH CAROLINA



FEBRUARY, 1995

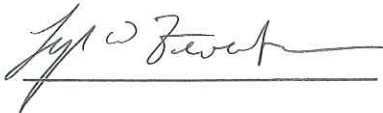
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Registered Professional Engineer



## Consultant Scour Study Check List

County Dorchester Crossing Ashley River  
 Road/Route US17A  
 Consultant Agres

Mark whether each item is completed correctly or incorrectly and make a comment as to what needs to be changed.

Check List	Correct	Incorrect	Comments
County	✓		
Structure #	✓		
Stream Name	✓		
Physiographic Province	✓		
Description of Location	✓		
Bridge Length and Width	✓		
Max Span Length	✓		
# of Spans	✓		
D50	✓		
Skew	✓		
Q100		✓	Used FIS FEMA Qs
Q500		✓	" "
Discharge Method and applicability		✓	" "
WSPRO Cross section Locations	✓		
WSPRO Setup	✓		
Inputs for scour against WSPRO			
Equations for Scour	✓		

\* TIDALY INFLUENCED SITE. DO NOT APPLY ENVELOPE CURVES - N/A FOR TIDAL SITES

ANZ  
1-22-02

D768401 09/14/01

PAGE 1

NATIONAL BRIDGE INVENTORY - - - - - STRUCTURE INVENTORY AND APPRAISAL

\*\*\*\*\* IDENTIFICATION \*\*\*\*\*

(1) STATE NAME - SOUTH CAROLINA # 000182001707500 CODE 454

(8) STRUCTURE NUMBER 122000170

(5) INVENTORY ROUTE (ON/UNDER) - ON = 122000170

(2) STATE HIGHWAY DEPARTMENT DISTRICT 6

(3) COUNTY CODE 18 (4) PLACE CODE 0

(6) FEATURES INTERSECTED - ISLANDS BRG-ASHLEY RIV

(7) FACILITY CARRIED - US 17 ALT

(9) LOCATION - 6 MI S SUMR'VL

(11) MILEPOINT 9.100

(16) LATITUDE 32 DEGREES 58 MINUTES 06.00 SECONDS

(17) LONGITUDE 80 DEGREES 15 MINUTES 18.00 SECONDS

(98) BORDER BRIDGE STATE CODE %SHARE %

(99) BORDER BRIDGE STRUCTURE NO. #

(43) STRUCTURE TYPE MAIN: MATERIAL - CONCRETE

(44) STRUCTURE TYPE APPR: MATERIAL - OTHER

(45) NUMBER OF SPANS IN MAIN UNIT CODE 000

(46) NUMBER OF APPROACH SPANS CODE 7

(107) DECK STRUCTURE TYPE - CONCRETE CAST-IN-PL CODE 1

(108) WEARING SURFACE / PROTECTIVE SYSTEM: CODE 1

A) TYPE OF WEARING SURFACE - CONCRETE CODE 8

B) TYPE OF MEMBRANE - UNKNOWN CODE 8

C) TYPE OF DECK PROTECTION - UNKNOWN CODE 8

\*\*\*\*\* AGE AND SERVICE \*\*\*\*\*

(27) YEAR BUILT 1971

(106) YEAR RECONSTRUCTED

(42) TYPE OF SERVICE ON - HIGHWAY

(28) LANES: ON STRUCTURE 2 UNDER STRUCTURE 15

(29) AVERAGE DAILY TRAFFIC 11200

(30) YEAR OF ADT 1999 06 %

(19) BYPASS, DETOUR LENGTH 1 MI

\*\*\*\*\* GEOMETRIC DATA \*\*\*\*\*

(48) LENGTH OF MAXIMUM SPAN 25 FT

(49) STRUCTURE LENGTH 210 FT

(50) CURB OR SIDEWALK: LEFT FT RIGHT FT

(51) BRIDGE ROADWAY WIDTH CURB TO CURB 44.0 FT

(52) DECK WIDTH OUT TO OUT 45.0 FT

(32) APPROACH ROADWAY WIDTH (W/SHOULDERS) 36 FT

(33) BRIDGE MEDIAN - NO MEDIAN CODE 0

(34) SKEW 2 DEG (35) STRUCTURE FLARED NO

(10) INVENTORY ROUTE MIN VERT CLEAR 99 FT 99 IN

(47) INVENTORY ROUTE TOTAL HORIZ CLEAR 44.0 FT

(54) MIN VERT CLEAR OVER BRIDGE ROADWAY 99 FT 99 IN

(55) MIN VERT UNDERCLEAR REF - OTHER FT IN

(56) MIN LAT UNDERCLEAR RT REF - OTHER FT

MIN LAT UNDERCLEAR LT FT

SUFFICIENCY RATING = 97.2

\*\*\*\*\* CLASSIFICATION \*\*\*\*\*

(112) NBIS BRIDGE LENGTH - CODE YES

(104) HIGHWAY SYSTEM -

(26) FUNCTIONAL CLASS -

(100) STRAIGHT HIGHWAY - NOT STRAIGHT HWY 0

(101) PARALLEL STRUCTURE - NONE EXIST N

(102) DIRECTION OF TRAFFIC - 2-WAY TRAFFIC 2

(103) TEMPORARY STRUCTURE - NOT TEMPORARY 0

(110) DESIGNATED NATIONAL NETWORK - NOT PART 3

(20) TOLL - ON FREE ROAD 1

(21) MAINTAIN - STATE HIGHWAY AGENCY 1

(22) OWNER - SCDOT 1

(37) HISTORICAL SIGNIFICANCE - NOT ELIGIBLE 5

\*\*\*\*\* CONDITION \*\*\*\*\*

(58) DECK 7

(59) SUPERSTRUCTURE 7

(60) SUBSTRUCTURE 7

(61) CHANNEL & CHANNEL PROTECTION 8

(62) CULVERTS N

\*\*\*\*\* LOAD RATING AND POSTING \*\*\*\*\*

(31) DESIGN LOAD HS-20 5

(64) OPERATING RATING - HS 69

(66) INVENTORY RATING - HS 42

(70) BRIDGE POSTING - NO POSTING REQUIRED 5

(41) STRUCTURE OPEN, POSTED OR CLOSED - DESCRIPTION - OPEN - NO RESTRICTIONS A

\*\*\*\*\* APPRAISAL \*\*\*\*\*

(67) STRUCTURE EVALUATION CODE 7

(68) DECK GEOMETRY 6

(69) UNDERCLEARANCES, VERTICAL & HORIZONTAL N

(71) WATERWAY ADEQUACY 6

(72) APPROACH ROADWAY ALIGNMENT 8

(36) TRAFFIC SAFETY FEATURES 0111

(113) SCOUR CRITICAL BRIDGES 3

\*\*\*\*\* PROPOSED IMPROVEMENTS \*\*\*\*\*

(75) TYPE OF WORK - CODE

(76) LENGTH OF STRUCTURE IMPROVEMENT 000210 FT

(94) BRIDGE IMPROVEMENT COST \$ 177,000

(95) ROADWAY IMPROVEMENT COSTS \$ 17,000

(96) TOTAL PROJECT COST \$ 265,000

(97) YEAR OF IMPROVEMENT COST ESTIMATE 2019

(114) FUTURE ADT 017024

(115) YEAR OF FUTURE ADT 2019

```

***** NAVIGATION DATA *****
(38) NAVIGATION CONTROL - NO NAV. CONTROL          CODE 0
(111) PIER PROTECTION - N/A                       CODE
(39) NAVIGATION VERTICAL CLEARANCE                FT
(116) VERT-LIFT BRIDGE NAV MIN VERT CLEAR        FT
(40) NAVIGATION HORIZONTAL CLEARANCE              FT

SIA.TXT

***** INSPECTIONS *****
(90) INSPECTION DATE 05/00 (91) FREQUENCY 24 MO
(92) CRITICAL FEATURE INSPECTION:
A) FRACTURE CRIT DETAIL - NO - MO A) /
B) UNDERWATER INSP - NO - MO B) /
C) OTHER SPECIAL INSP - NO - MO C) /

```

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**SUMMARY REPORT**  
**LEVEL II BRIDGE SCOUR ANALYSIS**  
**STRUCTURE NO. 18-2-0017-0-75-00**  
**US 17A OVER ASHLEY RIVER**  
**DORCHESTER COUNTY, SOUTH CAROLINA**

**1.1 Introduction**

This report presents the results of a Level II analysis of scour potential at Structure No. 18-2-0017-0-75-00, US 17A over Ashley River in Dorchester County, South Carolina. This work was authorized by Supplemental Agreement No. 4701-94 of Contract No. 747 (CEI Job No. 1844).

**1.2 Description of the Site and Bridge**

The site is located in the Lower Coastal Plain physiographic province near the town of Slandsville in Dorchester County. Ashley River is a significant drainage which flows to the Atlantic near Charleston, South Carolina. Figure 1 shows the topography in the vicinity of the bridge and Photographs 1 through 6 show typical views of the bridge and upstream and downstream conditions.

The US 17A crossing of Ashley River consists of a single 210-foot long, two-lane bridge. The bridge consists of seven 30-foot long concrete spans, supported by steel h-pile bents with spill-through abutments. The left abutment is protected with rip-rap. The right abutment is unprotected and signs of erosion are present. Additional details describing conditions at the site are included in Section 2.0 of this report.

**1.3 Hydraulics**

The drainage area for the site is 214 mi<sup>2</sup>. Land use is predominantly rural with some encroaching development. Figure 2 shows a map of the tributary drainage area. In the vicinity of the study site, the land is covered by moderate to dense woods, consisting primarily of deciduous trees.

In the study area, Ashley River is sinuous with a slope of approximately 0.00018 ft/ft (.95 ft/mi). The average channel top width is 150 feet (at the bridge) and the average channel depth is 6.0 feet (at the bridge). The channel is fairly well defined both upstream and downstream of the bridge. The channel is well defined both upstream and downstream of the bridge. Heavy tree coverage is found in the surrounding area. The predominant channel bed material is fine clayey sand with some silt. The channel banks consist primarily of clayey sand. In general, the banks have a heavy vegetative cover and were noted to be relatively stable at the time of the site visit.

#### **1.4 Scour Analysis**

The scour analysis was made using engineering judgement and the general guidelines described in Hydraulic Engineering Circular No. 18 (Richardson and others, Second edition-1993) and the Transportation Research Board draft paper, "Evaluating Scour at Bridges Using WSPRO" (Arneson and others, 1992). Scour calculations were made assuming an infinite depth of erosive material and a homogeneous particle size distribution. The bridge is influenced by both riverine and tidal flows. Based on the 1994 FEMA Flood Insurance Study, which incorporated both riverine and tidal surge analyses, riverine conditions were assumed to control scour conditions.

The results of the scour analysis are presented in Tables 1 and 2 and graphs of the scour depths are presented in Figures 5 and 6. The maximum total scour depths predicted for the 100-year and 500-year discharges are 8.5 and 10.5 feet, respectively.

#### **1.5 Conclusions and Recommendations**

The predicted scour depths for both the 100-year and 500-year discharges do not exceed the depth of embedment of the piles. However structural stability may be compromised due to the potential scour depths. Therefore, it is recommended that the structural integrity under scour conditions be evaluated and countermeasures be designed, as required.



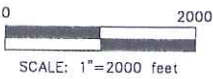
STRUCTURE NO. 18-2-0017-0-07-00  
 US 17A OVER ASHLEY RIVER



DORCHESTER COUNTY



GRAPHIC SCALE



COLLINS ENGINEERS, INC.

243 McLAWS CIRCLE  
 WILLIAMSBURG, VIRGINIA 23185  
 (804) 220-1904

FEBRUARY, 1995

SOUTH CAROLINA  
 DEPARTMENT OF TRANSPORTATION

STR. NO. 18-2-0017-0-75-00  
 US 17A OVER ASHLEY RIVER

TOPOGRAPHY AT  
 BRIDGE VICINITY

FIG. NO.

1

2/27/95 GAF

17A2\_ASH.DWG



## UNIT ABBREVIATIONS

cubic foot per second	ft <sup>3</sup> /s
feet per second	ft/s
foot	ft
mile	mi
millimeter	mm
square foot	ft <sup>2</sup>
square mile	mi <sup>2</sup>

## OTHER ABBREVIATIONS

downstream	D/S
upstream	U/S
northbound lane	NBL
southbound lane	SBL
eastbound lane	EBL
westbound lane	WBL
flood plain	f/p
median diameter of bed material	D <sub>50</sub>
South Carolina Department of Transp.	SC DOT

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In this report, "right" and "left" refer to directions facing downstream.

## 2.0 DETAILS OF SCOUR ANALYSIS

Structure Number(s) 18-2-0017-0-75-00 Stream Ashley River  
County Dorchester Route US 17A District 7

### 2.1 Description of Bridge(s):

Bridge Length 210 ft Bridge Width 48.0 ft Max. Span Length 30 ft  
Alignment of Bridge to Road (on curve or straight) straight  
Abutment Type spill through Embankment Type sloping  
Riprap on Abutment left only Date of Site Visit 1-5-95  
Description of Riprap Only the left abutment is well covered. The right abutment is eroding and has no riprap.

Brief Description of Piers/Pile Bents Eight sets of bents - each bent has seven 10-inch square steel h-piles. Each bent has a 2.5-foot wide by 2.5-foot high concrete cap.

Is Bridge Skewed to Flood Plain According to USGS Topo Map? yes Angle 15  
Is Bridge Located on a Bend in the Channel? no If so, describe (mild, moderate, severe)

#### Debris Accumulation on Bridge at Time of Site Visit:

Date of Site Visit	Percent of Channel Blocked Horizontally	Percent of Channel Blocked Vertically
1-5-95	>10%	<5%

Potential for Debris Moderate potential for debris due to likelihood of high flow in heavily wooded, vegetated swampy flood plain.

Describe any features near or at the bridge that may affect flow (include observation date).

None

## 2.2 Description of Flood Plain:

**General Topography** Generally flat, swampy flood plain upstream and downstream. Some localized rises present, as well as swamp drains.

### Flood Plain Conditions at Bridge Site: Downstream (D/S), Upstream (U/S)

**Date of Site Visit** 1-5-95

**D/S Left:** Heavily wooded with some trees and dense brush

**D/S Right:** Heavily wooded with mature trees and dense brush

**U/S Left:** Heavily wooded with mature trees and brush

**D/S Right:** Heavily wooded with mature trees and brush

## 2.3 Description of Channel:

**Average Top Width** 150 ft (at bridge)      **Average Depth** 6.0 ft

**Predominant Bed Material** fine clayey sand      **Bank Material** clayey sand

**Stream Type (straight, meandering, braided, swampy, channelized)** straight, swampy

**Vegetative Cover on Channel Banks Near Bridge:**      **Date of Site Visit** 1-5-95

**D/S Left:** Heavily vegetated embankments with bushes and many trees.

**D/S Right:** Heavily vegetated embankments with bushes and many trees.

**U/S Left:** Heavily vegetated embankments with bushes and many trees.

**U/S Right:** Heavily vegetated embankments with bushes and many trees.

**Do Banks Appear Stable?** Yes      **If not, Describe Location and Type of Instability and Date of Observation**

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Describe any Obstructions and Date of Observation** None

\_\_\_\_\_  
\_\_\_\_\_



## 2.5 Description of the Water Surface Profile (WSPRO) Model:

Datum for WSPRO Analysis (USGS Survey, Sea Level, SC DOT USGS Survey)

Datum Tie, if available No ties available in vicinity of site.

Briefly Describe the Survey Data Used to Develop WSPRO The bridge opening was surveyed at the time of the site visit. The Exit, Full Valley and Approach Sections were developed by synthesizing the bridge opening survey. The original roadway plans and the topographic contours from 7.5-minute topographic maps of the bridge vicinity.

### Cross-Sections Used in WSPRO Analysis

Cross-Section ID*	Section Reference Distance (SRD), ft	How Cross-Section was Developed**	Comments
EXIT	-210	4	Exit Section
FULV	0	4	Full Valley Section
BRDG	0	1	D/S Bridge Section
ROAD	24	4	Roadway Section
USAPR	250	4	Approach Section

\* For location of cross-sections, see topographic map (Figure 1). For more detail on how cross-sections were developed, see WSPRO input file.

\*\* Cross-section development: 1) survey at SRD; 2) shift of survey data to SRD; 3) modification of survey data based on topographic map; 4) synthesized by combining channel survey data and topographic contours; 5) other

**Starting Water Surface Elevation for WSPRO Analysis (place x on appropriate line):**

used slope/conveyance and confirmed by testing for convergence when reasonably possible.

used known water surface elevation. Describe \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Describe any Special Assumptions or Considerations Made in Developing WSPRO Model**

## 2.6 Bridge Hydraulics:

Average Embankment Elevation	<u>24.3</u>	ft
Average Low Steel Elevation	<u>20.1</u>	ft

<b>100-Year Discharge</b>	<u>10070</u>	ft <sup>3</sup> /s
<b>Water Surface Elevation at D/S Bridge Face</b>	<u>19.15</u>	ft
<b>Area of Flow at D/S Bridge Face</b>	<u>1995</u>	ft <sup>2</sup>
<b>Average Velocity in Bridge Opening</b>	<u>5.05</u>	ft/s
<b>Maximum WSPRO Tube Velocity at Bridge</b>	<u>7.85</u>	ft/s
<b>Water Surface Elevation at Approach Section With Bridge</b>	<u>19.86</u>	ft
<b>Water Surface Elevation at Approach Section Without Bridge</b>	<u>19.22</u>	ft
<b>Amount of Backwater Caused by Bridge</b>	<u>.64</u>	ft

<b>500-Year Discharge</b>	<u>15510</u>	ft <sup>3</sup> /s
<b>Water Surface Elevation at D/S Bridge Face</b>	<u>20.10</u>	ft
<b>Area of Flow at D/S Bridge Face</b>	<u>2072</u>	ft <sup>2</sup>
<b>Average Velocity in Bridge Opening</b>	<u>7.63</u>	ft/s
<b>Maximum WSPRO Tube Velocity at Bridge</b>	<u>11.29</u>	ft/s
<b>Water Surface Elevation at Approach Section With Bridge</b>	<u>22.84</u>	ft
<b>Water Surface Elevation at Approach Section Without Bridge</b>	<u>20.88</u>	ft
<b>Amount of Backwater Caused by Bridge</b>	<u>1.96</u>	ft

## 2.7 Scour Computations

### **Describe any Special Assumptions or Considerations Made in Bridge Scour Analysis**

The scour analysis was made using engineering judgement and the general guidelines described in Hydraulic Engineering Circular No. 18, "Evaluating Scour at Bridges (Richardson and others, Second Edition-1993)", and the Transportation Research Board Draft Paper, "Evaluating Scour at Bridges Using WSPRO" (Arneson and others, 1992). Scour calculations were made assuming an infinite depth of erosive material and a homogeneous particle-size distribution. The results of the scour analysis are presented in Tables 1 and 2 and graphs of the scour depths are presented in Figures 5 and 6.

Soil borings provided on the bridge drawings (and confirmed by field observation) indicate a fine sand throughout. Using sieve analysis data from the bridge plans,  $D_{50}$  was determined to be 0.055 mm.

Upstream velocities in the channel at the Approach Section are high, indicative of live-bed scour. Using Neill's equation from HEC-18 for determining the velocity associated with initiation of motion, a velocity over .98 feet per second is required for live-bed scour. For this report, live-bed scour will be assumed. Scour depths were computed for the 100-year and 500-year discharges. Contraction scour computations were made based upon Case 1 conditions (overbank flow on floodplain being forced back to the main channel by the approaches to the bridge). The local scour computations were made assuming a 15 degree skew angle, seven square h-piles per bent and no debris. Abutment scour was considered likely at the right abutment due to the lack of protection and current signs of erosion.

Hydrologic calculations were based on the reported 100-and 500-year discharges at US17A from the Flood Insurance Study of Dorchester County, South Carolina- Unincorporated Areas. Revised April 15, 1994 by the Federal Emergency Management Agency.

Figure 3 provides a graph of the most constricted bridge face (D/S Bridge Face) used in the WSPRO analysis and scour calculations. Figure 4 is a graph of the Approach Section used in the WSPRO analysis.

**Table 1**  
 Cumulative scour depths at piers/bents for the 100-year discharge at  
 Structure No. 18-2-0017-0-75-00  
 US 17A Over Ashley River, Dorchester County, South Carolina

<b>Pier/Bent<sup>1</sup> Number</b>	<b>Station from<sup>2</sup> Left End of Bridge (ft)</b>	<b>Contraction Scour Depth (ft)</b>	<b>Pier/Bent Scour Depth (ft)</b>	<b>Total Scour<sup>3</sup> Depth (ft)</b>	<b>Remaining Embedment Depth (ft)</b>
<b>100-Year Discharge is 10,070 cfs</b>					
2	30	1.6	3.1	4.7	20.2
3	60	1.6	5.5	7.1	16.6
4	90	1.6	6.8	8.4	10.0
5	120	1.6	6.9	8.5	8.7
6	150	1.6	6.7	8.3	7.8
7	180	1.6	3.0	4.6	19.0

- 1 Pier/bent numbering is ordered left-to-right looking downstream.
- 2 Stations are determined from left to right looking downstream.
- 3 Total scour depth is the sum of the contraction and pier/bent scour depths.

NOTE: The pier and contraction scour equations used in this scour analysis were those recommended in Hydraulic Engineering Circular 18 (Richardson and others, Second Edition-1993). Scour calculations were made assuming an infinite depth of erosive material and a homogeneous particle-size distribution.

**Table 2**  
 Cumulative scour depths at piers/bents for the 500-year discharge at  
 Structure No. 18-2-0017-0-75-00  
 US 17A Over Ashley River, Dorchester County, South Carolina

Pier/Bent <sup>1</sup> Number	Station from <sup>2</sup> Left End of Bridge (ft)	Contraction Scour Depth (ft)	Pier/Bent Scour Depth (ft)	Total Scour <sup>3</sup> Depth (ft)	Remaining Embedment Depth (ft)	
<b>500-Year Discharge is 15,510 cfs</b>						
2	11.9	30	2.4	3.6	6.0	18.9
3	9.7	60	2.4	6.5	8.9	14.8
4	4.1	90	2.4	7.9	10.3	8.1
5	3.2	120	2.4	8.1	10.5	6.7
6	4.1	150	2.4	7.9	10.3	5.8
7	13.4	180	2.4	3.5	5.9	17.7

- 1 Pier/bent numbering is ordered left-to-right looking downstream.
- 2 Stations are determined from left to right looking downstream.
- 3 Total scour depth is the sum of the contraction and pier/bent scour depths.

**NOTE:** The pier and contraction scour equations used in this scour analysis were those recommended in Hydraulic Engineering Circular 18 (Richardson and others, Second Edition-1993). Scour calculations were made assuming an infinite depth of erosive material and a homogeneous particle-size distribution.

# US 17A SLANDS BRIDGE OVER ASHLEY RIVER

## Downstream Bridge Face

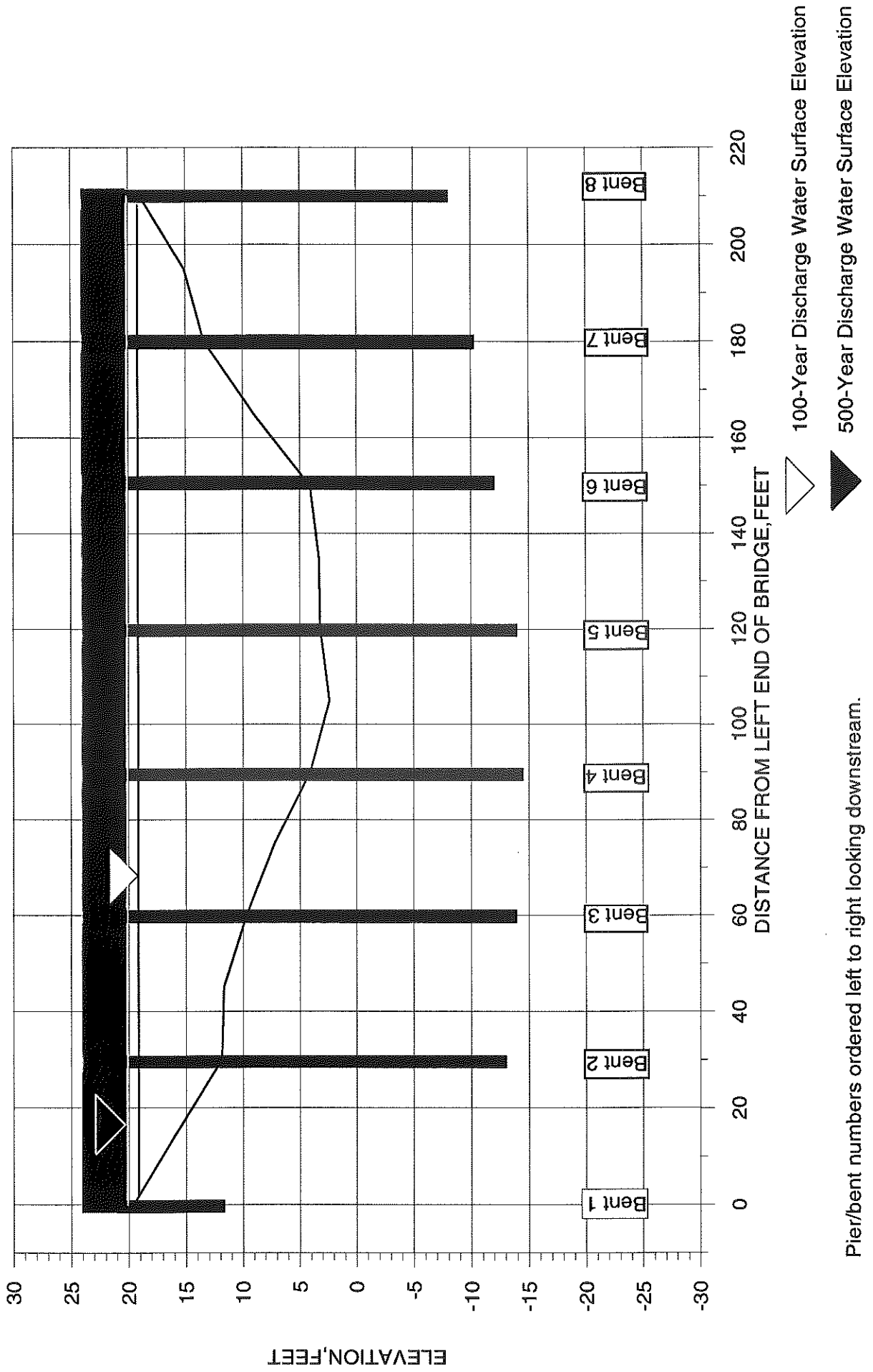


FIGURE 3. Downstream main bridge face input to the WSPRO model.

# US 17A SLANDS BRIDGE OVER ASHLEY RIVER

## Approach Cross Section

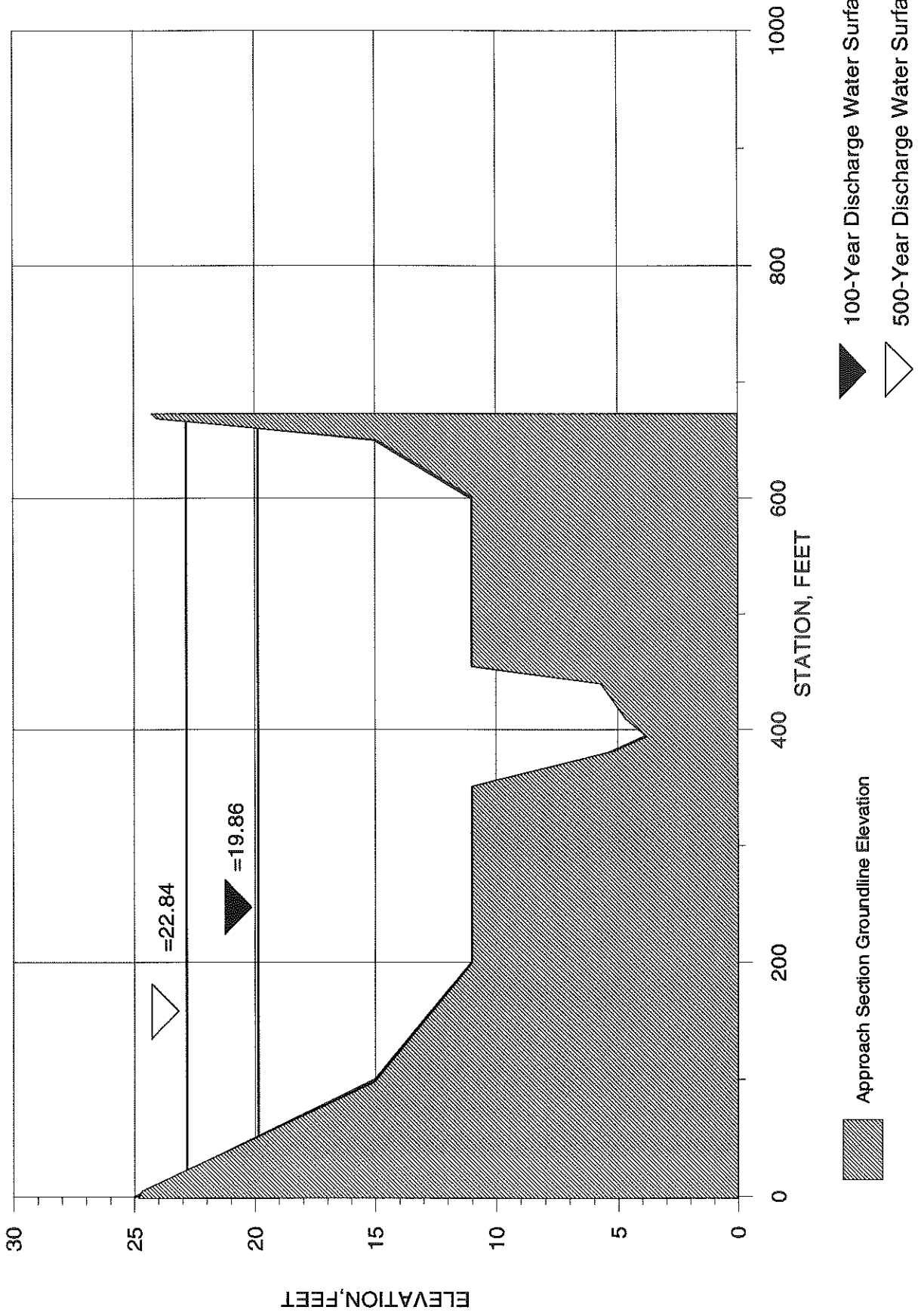


FIGURE 4. Approach cross-section input to the WSPRO model.

# US 17A SLANDS BRIDGE OVER ASHLEY RIVER 100-Year Discharge

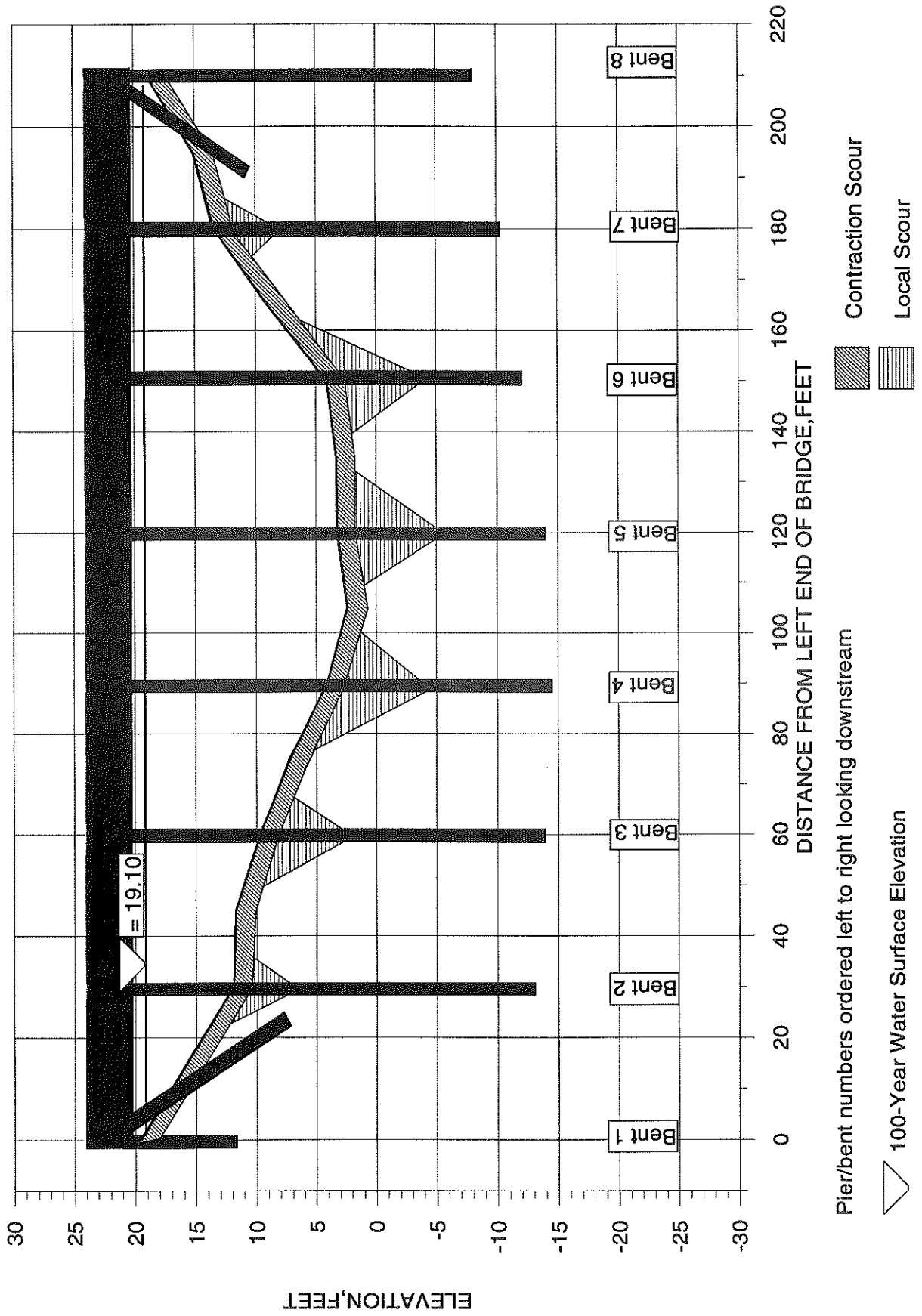


FIGURE 5. Scour depths for 100-year discharge.

# US 17A SLANDS BRIDGE OVER ASHLEY RIVER

## 500-Year Discharge

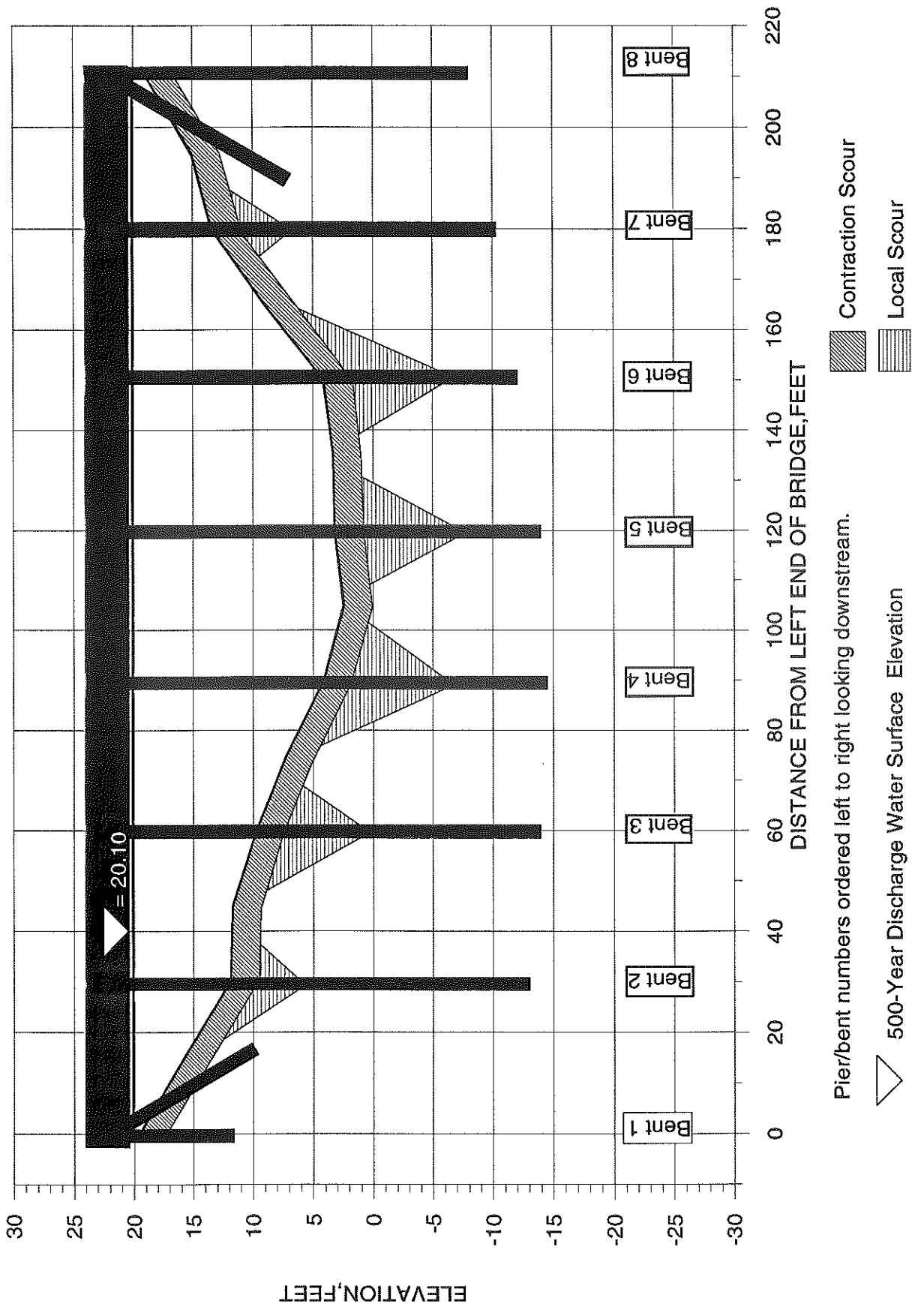


FIGURE 6. Scour depths for 500-year discharge.

## APPENDIX A

### List of Photographs

Photograph 1	View of downstream fascia looking north.
Photograph 2	View of upstream fascia looking south.
Photograph 3	View of riprap protected left abutment.
Photograph 4	View of unprotected right abutment.
Photograph 5	View of upstream channel.
Photograph 6	View of downstream channel.



**Photograph 1**

View of downstream fascia looking north.



**Photograph 2**

View of upstream fascia looking south.



**Photograph 3**

View of rip-rap protected left abutment.



**Photograph 4**

View of unprotected right abutment.



**Photograph 5**

View of upstream channel.



**Photograph 6**

View of downstream channel.

## APPENDIX B

### WSPRO Input and Selected Output Files

WSPRO INPUT

T1 US 17A OVER ASHLER RIVER (ISLANDS BR)  
T2 FILE SLANDS.WSP JDS AYRES ASSOC. 2/95  
T3 DORCHESTER COUNTY, SC  
\*  
\* STRUCTURE NUMBER 18-2-0017-0-75-00  
\*  
\* Q100 Q500 (FROM FEMA FIS)  
Q 10070 15510  
\* THIS ENERGY SLOPE MATCHES THE 100-YR FEMA WATER SURFACE  
SK 0.000180 0.000180  
\*  
XS EXIT -210,\*,\*,\*,.0003  
GR 0,35 250,30 380,25 450,20 550,15 650,11 800,11 830,5.4  
GR 845,3.8 860,4.6 890,5.6 905,11.0 1100,15 1500,15  
GR 5400,15 5410,20  
N 0.180 0.040 0.180  
SA 800 905  
\*  
XS FULV 0  
\*  
\* SLANDS BRIDGE  
BR BRDG 0,20.1,15  
GR 750,20.1 751,19.6 765,15.8 780,11.9  
GR 795,11.7 810,9.7 825,7.2 840,4.1 855,2.4 870,3.2 885,3.3  
GR 900,4.1 915,9.0 930,13.4 945,15.1 959,18.9 960,20.1 750,20.1  
CD 3 48 2 24.3  
PW 1 3.2,0.83 4.1,2.50 9.7,3.33 11.9,4.17 13.4,5 17.1,15 20.1,15  
\*  
\* ROAD GRADE  
XR ROAD 24,24,1,\*,0  
GR 500,24.3 1000,24.3  
\*  
\* APPROACH  
AS APPR 250  
GR 0,25 50,20 100,15 200,11 350,11 380,5.4 395,3.8  
GR 410,4.6 440,5.6 455,11 500,11 600,11 650,15 670,24  
N 0.180 0.040 0.18  
SA 300 500  
\*  
HP 2 BRDG 19.15,\*,\*,10070  
HP 1 BRDG 19.15,1,19.15  
HP 2 APPR 19.86,\*,\*,10070  
HP 1 APPR 19.86,1,19.86  
\*  
HP 2 BRDG 20.10,\*,\*,15563  
HP 1 BRDG 20.10,1,20.10  
HP 2 APPR 22.84,\*,\*,15563  
HP 1 APPR 22.84,1,22.84  
\*  
EX

\*  
ER

WSPRO OUTPUT

1

WSPRO FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY  
 P060188 MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS  
 (Input modified to free format by GKY&A 01/92)

US 17A OVER ASHLER RIVER (ISLANDS BR)  
 FILE SLANDS.WSP JDS AYRES ASSOC. 2/95  
 DORCHESTER COUNTY, SC  
 \*\*\* RUN DATE & TIME: 03-02-95 15:29

VELOCITY DISTRIBUTION: ISEQ = 3; SECID = BRDG ; SRD = 0.

	WSEL	LEW	REW	AREA	K	Q	VEL
	19.15	752.7	959.2	1995.7	322223.	10070.	5.05
X STA.	752.7	809.5	820.0	827.7	834.0	839.6	
A(I)		321.1	104.0	88.0	79.9	76.9	
V(I)		1.57	4.84	5.72	6.30	6.55	
X STA.	839.6	844.3	848.8	853.1	857.2	861.3	
A(I)		70.0	68.7	67.3	66.8	64.2	
V(I)		7.19	7.33	7.48	7.54	7.85	
X STA.	861.3	865.4	869.8	874.3	878.9	883.4	
A(I)		65.5	68.7	69.2	69.8	68.9	
V(I)		7.69	7.33	7.28	7.22	7.31	
X STA.	883.4	888.0	892.6	897.4	902.4	959.2	
A(I)		70.0	70.0	71.0	71.7	364.0	
V(I)		7.19	7.19	7.09	7.02	1.38	

1

HP 1 BRDG 19.15,1,19.15

1

WSPRO FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY  
 P060188 MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS  
 (Input modified to free format by GKY&A 01/92)

US 17A OVER ASHLER RIVER (ISLANDS BR)  
 FILE SLANDS.WSP JDS AYRES ASSOC. 2/95  
 DORCHESTER COUNTY, SC

\*\*\* RUN DATE & TIME: 03-02-95 15:29

CROSS-SECTION PROPERTIES: ISEQ = 3; SECID = BRDG ; SRD = 0.

WSEL	SA#	AREA	K	TOPW	WETP	ALPH	LEW	REW	QCR
	1	241.	5947.	46.	47.				3136.
	2	1426.	307220.	101.	102.				30332.
	3	329.	9056.	52.	54.				4682.
19.15		1996.	322223.	200.	204.	1.70	753.	959.	27474.

1

HP 2 APPR 19.86,\*,\*,10070

1

WSPRO FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY  
 P060188 MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS  
 (Input modified to free format by GKY&A 01/92)

US 17A OVER ASHLER RIVER (ISLANDS BR)  
 FILE SLANDS.WSP JDS AYRES ASSOC. 2/95  
 DORCHESTER COUNTY, SC  
 \*\*\* RUN DATE & TIME: 03-02-95 15:29

VELOCITY DISTRIBUTION: ISEQ = 5; SECID = APPR ; SRD = 250.

	WSEL	LEW	REW	AREA	K	Q	VEL
	19.86	51.4	660.8	5216.8	516132.	10070.	1.93
X STA.	51.4	221.0	300.8	320.5	339.5	357.9	
A(I)		990.5	706.2	174.6	168.6	169.3	
V(I)		.51	.71	2.88	2.99	2.97	
X STA.	357.9	369.9	379.1	387.2	394.4	401.6	
A(I)		136.9	123.2	120.0	112.9	114.9	
V(I)		3.68	4.09	4.20	4.46	4.38	
X STA.	401.6	409.2	416.8	424.8	432.8	441.1	
A(I)		117.7	115.1	118.5	117.6	119.4	
V(I)		4.28	4.38	4.25	4.28	4.22	
X STA.	441.1	453.2	472.6	491.6	547.4	660.8	
A(I)		141.2	172.6	168.2	494.5	835.2	
V(I)		3.57	2.92	2.99	1.02	.60	

1

HP 1 APPR 19.86,1,19.86

1

WSPRO FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY  
 P060188 MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS  
 (Input modified to free format by GKY&A 01/92)

US 17A OVER ASHLER RIVER (ISLANDS BR)  
 FILE SLANDS.WSP JDS AYRES ASSOC. 2/95  
 DORCHESTER COUNTY, SC  
 \*\*\* RUN DATE & TIME: 03-02-95 15:29

CROSS-SECTION PROPERTIES: ISEQ = 5; SECID = APPR ; SRD = 250.

WSEL	SA#	AREA	K	TOPW	WETP	ALPH	LEW	REW	QCR
	1	1690.	50164.	249.	249.				25006.
	2	2272.	425282.	200.	202.				43439.
	3	1255.	40686.	161.	162.				19901.
19.86		5217.	516132.	609.	613.	2.97	51.	661.	50275.

1

\*

HP 2 BRDG 20.10,\*,\*,15563

1

WSPRO FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY  
P060188 MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS  
(Input modified to free format by GKY&A 01/92)

US 17A OVER ASHLER RIVER (ISLANDS BR)  
FILE SLANDS.WSP JDS AYRES ASSOC. 2/95  
DORCHESTER COUNTY, SC  
\*\*\* RUN DATE & TIME: 03-02-95 15:29

VELOCITY DISTRIBUTION: ISEQ = 3; SECID = BRDG ; SRD = 0.

	WSEL	LEW	REW	AREA	K	Q	VEL
	20.10	750.0	960.0	2187.0	225982.	15563.	7.12
X STA.	750.0		808.0	818.5	826.5	832.9	838.4
A(I)		360.1		111.3	95.7	86.3	79.6
V(I)		2.16		6.99	8.13	9.01	9.78
X STA.	838.4		843.4	848.0	852.4	856.8	860.8
A(I)		77.7		74.6	73.1	73.8	68.9
V(I)		10.02		10.43	10.65	10.55	11.29
X STA.	860.8		865.1	869.6	874.2	878.8	883.4
A(I)		70.9		74.4	74.9	75.6	74.6
V(I)		10.98		10.46	10.39	10.30	10.44
X STA.	883.4		888.1	892.9	897.8	902.9	960.0
A(I)		75.8		75.8	77.0	77.5	409.5
V(I)		10.26		10.26	10.11	10.04	1.90

1

HP 1 BRDG 20.10,1,20.10

1

WSPRO FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY  
P060188 MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS  
(Input modified to free format by GKY&A 01/92)

US 17A OVER ASHLER RIVER (ISLANDS BR)  
FILE SLANDS.WSP JDS AYRES ASSOC. 2/95  
DORCHESTER COUNTY, SC  
\*\*\* RUN DATE & TIME: 03-02-95 15:29

CROSS-SECTION PROPERTIES: ISEQ = 3; SECID = BRDG ; SRD = 0.

WSEL	SA#	AREA	K	TOPW	WETP	ALPH	LEW	REW	QCR
	1	286.	4777.	-2.	100.				0.
	2	1522.	214064.	-4.	207.				0.



3 1744. 68376. 167. 169. 31949.  
 22.84 7087. 783305. 646. 650. 3.16 22. 667. 74982.

1

\*

EX

+++ BEGINNING PROFILE CALCULATIONS -- 2

1

WSPRO FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY  
 P060188 MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS  
 (Input modified to free format by GKY&A 01/92)

US 17A OVER ASHLER RIVER (ISLANDS BR)  
 FILE ISLANDS.WSP JDS AYRES ASSOC. 2/95  
 DORCHESTER COUNTY, SC

\*\*\* RUN DATE & TIME: 03-02-95 15:29

XSID:CODE	SRDL	LEW	AREA	VHD	HF	EGL	CRWS	Q	WSEL
SRD	FLEN	REW	K	ALPH	HO	ERR	FR#	VEL	
EXIT :XS	*****	466.	22602.	.04	*****	19.23	13.15	10070.	19.19
-210.	*****	5408.	750461.	14.09	*****	*****	.14	.45	

FULV :FV	210.	467.	22486.	.04	.04	19.27	*****	10070.	19.23
0.	210.	5408.	745511.	14.15	.00	.00	.14	.45	

<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>

===135 CONVEYANCE RATIO OUTSIDE OF RECOMMENDED LIMITS.  
 "APPR " KRATIO = .62

APPR :AS	250.	58.	4830.	.20	.07	19.42	*****	10070.	19.22
250.	250.	659.	465096.	2.92	.08	.00	.22	2.08	

<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>

<<<<RESULTS REFLECTING THE CONSTRICTED FLOW FOLLOW>>>>

XSID:CODE	SRDL	LEW	AREA	VHD	HF	EGL	CRWS	Q	WSEL
SRD	FLEN	REW	K	ALPH	HO	ERR	FR#	VEL	
BRDG :BR	210.	753.	1995.	.50	.09	19.65	12.01	10070.	19.15
0.	210.	959.	322031.	1.27	.33	.00	.32	5.05	

TYPE	PPCD	FLOW	C	P/A	LSEL	BLEN	XLAB	XRAB
3.	1.	1.	.887	.050	20.10	*****	*****	*****

XSID:CODE	SRD	FLEN	HF	VHD	EGL	ERR	Q	WSEL
ROAD :RG	24.							

<<<<EMBANKMENT IS NOT OVERTOPPED>>>>

XSID:CODE	SRDL	LEW	AREA	VHD	HF	EGL	CRWS	Q	WSEL
SRD	FLEN	REW	K	ALPH	HO	ERR	FR#	VEL	
APPR :AS	202.	51.	5217.	.17	.33	20.03	12.82	10070.	19.86

250. 537. 661. 516121. 2.97 .06 .00 .20 1.93  
M(G) M(K) KQ XLKQ XRKQ OTEL  
.656 .172 427461. 293. 500. 19.77

<<<<<END OF BRIDGE COMPUTATIONS>>>>>

1

WSPRO FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY  
P060188 MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS  
(Input modified to free format by GKY&A 01/92)

US 17A OVER ASHLER RIVER (ISLANDS BR)  
FILE SLANDS.WSP JDS AYRES ASSOC. 2/95  
DORCHESTER COUNTY, SC  
\*\*\* RUN DATE & TIME: 03-02-95 15:29

XSID:CODE	SRDL	LEW	AREA	VHD	HF	EGL	CRWS	Q	WSEL
SRD	FLEN	REW	K	ALPH	HO	ERR	FR#	VEL	
EXIT :XS	*****	437.	31091.	.04	*****	20.94	16.32	15510.	20.90
-210.	*****	5410.	1154964.	10.79	*****	*****	.12	.50	

===140 AT SECID "FULV ": END OF CROSS SECTION EXTENDED VERTICALLY.  
WSEL,YLT,YRT = 20.94 35.06 20.06

FULV :FV	210.	438.	30973.	.04	.04	20.98	*****	15510.	20.94
0.	210.	5410.	1148852.	10.83	.00	.00	.12	.50	

<<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

===135 CONVEYANCE RATIO OUTSIDE OF RECOMMENDED LIMITS.  
"APPR " KRATIO = .52

APPR :AS	250.	41.	5843.	.33	.09	21.21	*****	15510.	20.88
250.	250.	663.	602033.	3.04	.15	.00	.27	2.65	

<<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

===255 ATTEMPTING FLOW CLASS 3 (6) SOLUTION.  
WS3N,LSEL = 20.94 20.10

<<<<<RESULTS REFLECTING THE CONSTRICTED FLOW FOLLOW>>>>>

XSID:CODE	SRDL	LEW	AREA	VHD	HF	EGL	CRWS	Q	WSEL
SRD	FLEN	REW	K	ALPH	HO	ERR	FR#	VEL	
BRDG :BR	210.	750.	2072.	1.59	*****	21.69	14.36	15818.	20.10
0.	*****	960.	225982.	1.76	*****	*****	.57	7.63	

TYPE	PPCD	FLOW	C	P/A	LSEL	BLEN	XLAB	KRAB
3.	1.	3.	.800	.053	20.10	*****	*****	*****

XSID:CODE	SRD	FLEN	HF	VHD	EGL	ERR	Q	WSEL
ROAD :RG	24.							

<<<<<EMBANKMENT IS NOT OVERTOPPED>>>>>

XSID:CODE	SRDL	LEW	AREA	VHD	HF	EGL	CRWS	Q	WSEL
-----------	------	-----	------	-----	----	-----	------	---	------

	SRD	FLEN	REW	K	ALPH	HO	ERR	FR#	VEL
APPR :AS	202.	22.	7088.	.24	.73	23.08	14.06	15510.	22.84
	250.	534.	667.	783440.	3.16	.06	.02	.21	2.19

M(G)	M(K)	KQ	XLKQ	XRKQ	OTEL
*****	*****	*****	*****	*****	22.75

<<<<<END OF BRIDGE COMPUTATIONS>>>>>

\*

ER

1 NORMAL END OF WSPRO EXECUTION.

## APPENDIX C

### Scour Computations

**CONTRACTION SCOUR COMPUTATIONS  
FOR  
US 17A OVER ASHLEY RIVER  
STRUCTURE NO. 18-2-0017-0-75-00  
DORCHESTER COUNTY, SOUTH CAROLINA**

---

The following computations are made using the HEC-18 equation for Live Bed Contraction Scour:

$$Y_s = Y_2 - Y_1$$

$$Y_2 = \left( \frac{Q_2}{Q_1} \right)^{0.7} \left( \frac{W_1}{W_2} \right)^{k_1} Y_1$$


---

**100-YEAR DISCHARGE  
MAIN CHANNEL  
LIVE-BED CONTRACTION SCOUR COMPUTATIONS**

ENERGY SLOPE	=	0.00018
w FALL VELOCITY	=	0.0075
AVERAGE UPSTREAM CHANNEL DEPTH (FT), Y1	=	11.4
V- SHEAR VELOCITY IN UPSTREAM SECTION	=	0.26
V*/w	=	34.21
k <sub>1</sub> SEE PAGE 33 IN HEC-18	=	0.69
DISCHARGE IN UPSTREAM CHANNEL (CFS), Q1	=	8297
DISCHARGE IN CONTRACTED SECTION (CFS), Q2	=	10070
WIDTH OF UPSTREAM CHANNEL SECTION (FT), W1	=	200
WIDTH OF MAIN CHANNEL CONTRACTED SECTION (FT), W2	=	210
MEDIAN GRAIN SIZE (FT), D50	=	0.00018
COMPUTED WATER DEPTH OF CONTRACTED SECTION (FT),	=	13.0
AVERAGE UPSTREAM CHANNEL WATER DEPTH (FT), Y1	=	11.4
AVERAGE SCOUR DEPTH AT CONTRACTED SECTION (FT)	=	1.6

**CONTRACTION SCOUR COMPUTATIONS  
FOR  
US 17A OVER ASHLEY RIVER  
STRUCTURE NO. 18-2-0017-0-75-00  
DORCHESTER COUNTY, SOUTH CAROLINA**

---

The following computations are made using the HEC-18 equation for Live Bed Contraction Scour:

$$Y_s = Y_2 - Y_1$$

$$Y_2 = \left( \frac{Q_2}{Q_1} \right)^{6/7} \left( \frac{W_1}{W_2} \right)^{k_1} Y_1$$

---

**500-YEAR DISCHARGE  
MAIN CHANNEL  
LIVE-BED CONTRACTION SCOUR COMPUTATIONS**

ENERGY SLOPE	=	0.00018
w FALL VELOCITY	=	0.0075
AVERAGE UPSTREAM CHANNEL DEPTH (FT), Y1	=	14.3
V· SHEAR VELOCITY IN UPSTREAM SECTION	=	0.29
V*/w	=	38.39
k <sub>1</sub> SEE PAGE 33 IN HEC-18	=	0.69
DISCHARGE IN UPSTREAM CHANNEL (CFS), Q1	=	12459
DISCHARGE IN CONTRACTED SECTION (CFS), Q2	=	15563
WIDTH OF UPSTREAM CHANNEL SECTION (FT), W1	=	200
WIDTH OF MAIN CHANNEL CONTRACTED SECTION (FT), W2	=	210
MEDIAN GRAIN SIZE (FT), D50	=	0.00018
COMPUTED WATER DEPTH OF CONTRACTED SECTION (FT), Y	=	16.7
AVERAGE UPSTREAM CHANNEL WATER DEPTH (FT), Y1	=	14.3
AVERAGE SCOUR DEPTH AT CONTRACTED SECTION (FT)	=	2.4

**PIER SCOUR COMPUTATIONS  
FOR  
US 17A OVER ASHLEY RIVER  
STRUCTURE NO. 18-2-0017-0-75-00  
DORCHESTER COUNTY, SOUTH CAROLINA**

The following calculations are made using the HEC-18 equation for Pier Scour:

$$Y_s = (2 * K_1 * K_2 * K_3 * (Y_1/a)^{0.35} * Fr^{0.43}) * a$$

---

**SCOUR ANALYSIS FOR Q<sub>100</sub> - CASE 1 (WITHOUT DEBRIS)**

---

HYDRAULIC VARIABLES USED IN CSU EQUATION

	2	3	4	5	6	7
PIER/BENT NUMBER	2	3	4	5	6	7
PIER STATION (FT)	780.00	810.00	840.00	870.00	900.00	930.00
TOP WIDTH (FT)	56.80	10.50	4.70	4.50	5.00	56.80
AREA (FT <sup>2</sup> )	321.10	104.00	70.00	69.20	71.70	364.00
V1: VELOCITY (FPS)	1.57	4.84	7.19	7.28	7.02	1.38
Y1: DEPTH (FT)	5.65	9.90	14.89	15.38	14.34	6.41
ATTACK ANGLE	15.00	15.00	15.00	15.00	15.00	15.00
INDIVIDUAL BENT WIDTH	0.83	1.33	1.33	1.33	1.33	1.33
a: PIER WIDTH (FT)	0.83	0.83	0.83	0.83	0.83	0.83
L: PIER LENGTH (FT)	5.83	5.83	5.83	5.83	5.83	5.83
K1: SHAPE COEFFICIENT	1.10	1.10	1.10	1.10	1.10	1.10
K2: ANGLE COEFFICIENT	2.00	2.00	2.00	2.00	2.00	2.00
K3: BED COND. COEFFICIENT	1.10	1.10	1.10	1.10	1.10	1.10
FROUDE NUMBER	0.12	0.27	0.33	0.33	0.33	0.10
LOCAL SCOUR DEPTH (FT)	3.1	5.5	6.8	6.9	6.7	3.0

## APPENDIX D

### SELECTED REFERENCES

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